Suction Socket
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THE COMMITTEE ON ARTIFICIAL LIMBS
NATIONAL RESEARCH COUNCIL

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THE SUCTION SOCKET ABOVE-KNEE ARTIFICIAL LEG

A REVISED REPORT
PREPARED BY

THE PROSTHETIC DEVICES RESEARCH PROJECT
UNIVERSITY OF CALIFORNIA

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The suction socket above-knee prosthesis differs from the conventional leg in that it has no pelvic hinge or suspension harness. The leg is held on by a moderate suction created in the closed socket each time the leg is lifted from the ground. As compared with the conventional leg, the suction socket permits greater freedom of movement in all directions, feels more like an integral part of the body, and has less interference with clothing. This type of prosthesis has been used in Germany for years, and has been experimentally used with consistent success by selected amputees in various parts of the United States during the past two years.

During December 1947 and January 1948, sixteen short courses were held in various parts of the United States to start the training of limb manufacturers and orthopedic surgeons in the technical details of the suction socket above-knee legs. These training periods, which were one week long, served only as an introduction to the subject since considerable experience is required on the part of the limb manufacturer to fit the above-knee suction socket satisfactorily.

This report is published by the Advisory Committee on Artificial Limbs to supply information about the above-knee suction-socket leg to surgeons, manufacturers, and amputees. It is a revision of the preliminary report dated September, 1947.

While further experience may result in some modifications, the principal features of the suction-socket leg have become fairly well established. These features are described herein as the best available information to date. The program is continuing actively, and information from further development and use will be published whenever significant findings become available. It will be most helpful to the program if limb manufacturers and surgeons supervising the use of suction-socket legs will report their experiences frankly to the Advisory Committee on Artificial Limbs, National Research Council, 2101 Constitution Avenue, Washington 25, D.C.

HISTORY OF THE SUCTION SOCKET

The earliest known reference to the suction socket is in the form of a patent issued by the U. S. Patent Office, February 10, 1863 (Patent No. 37,637) to Dubois D. Parmelee of New York, N.Y. The principal idea was the attachment of the socket to the stump by atmospheric pressure. Subsequent patents have been issued to George C. Beacock and Terence Sparham of Brockville, Ontario, Canada, in 1885; to Justin Kay Toles of Stockton, California, in 1911; and to Ernest Walter Underwood of Birmingham, England, in 1926. Fundamental principals of the Beacock and Sparham suction socket differed but little from the Parmelee socket; Toles' description was basically the same but with the addition of a rubber tube and bag lining which could be inflated by air to assist in holding the socket on. The socket described by Underwood had smooth helical grooves which he claimed ventilated the stump as well as assisted in holding the socket in place.

A search of the literature has revealed only a few articles on the above-knee suction-socket leg. Little of England, in 1926, reported favorably on eleven suction-socket cases designed by Blatchford and made of metal which contained a smooth helical groove of a little more than one turn around the circumference of the socket. Some thirty cases were fitted at Roehampton (England) after World War I, using the metal socket with the helical groove. It is not known whether these thirty cases include the eleven reported by Little, but it is considered doubtful as several different groups were using the suction socket in England at that time. Use of the suction socket has been practically dormant in England for a number of years, but has been revived recently.

Pfau of Berlin says the suction socket has been known in Germany for twenty-five years but was not popularized until Oesterle in Ulm started his work in the early Thirties. Felix, a surgeon of Dusseldorf, reported on above-knee suction sockets in 1941. He stated that the suction socket had been used in Germany to some extent since World War I but was not popularized until a satisfactory valve had been constructed in 1932. After this accomplishment, numerous selected cases were successfully fitted.

In 1946, the U. S. Surgeon General's Office sent a Commission on Amputations and Prostheses to Europe to observe foreign practice. One principal item of interest was the successful use in Germany of suction-sockets for above-knee prostheses. The Advisory Committee on Artificial Limbs of the National Research Council then instituted a program to determine the possibilities and limitations of the suction-socket leg, as one activity of their general program of providing information regarding the best possible prostheses for the amputees of the United States. The Committee's work is sponsored by the Surgeon General's Office and the Veterans Administration and has had the cooperation of the Army and Navy Amputation Centers, many commercial limb manufacturers throughout the country, and the contractors working under the supervision of the Committee.

Recent Development in the United States

In order to determine the effect of widely diverse climatic conditions, subjects were selected in ten localities. The suction-socket legs were made by commercial limb manufacturers in general accordance with their regular materials and practices, but making use of supplementary information and supervision provided by representatives of the Advisory Committee on Artificial Limbs. The results were carefully recorded.

At the termination of the program in the ten localities on April 15, 1948, fifty-two subjects had been fitted. Forty of the subjects had been wearing the suction-socket leg regularly for four to twenty months; all were well satisfied and had no intention of returning to a pelvic-belt leg. Six of the subjects were still alternating between the suction-socket leg and the pelvic-belt leg due to improper fittings, nervous disorders, or lack of cooperation. The remaining six had been dropped from the program for personal reasons not involving the suction-socket leg. Aside from these 52 carefully controlled experimental subjects, it is estimated that there are approximately 300 amputees in the United States that are successfully wearing suction-socket legs.

CHARACTERISTICS OF THE SUCTION SOCKET

The only apparent difference between a suction-socket leg and the

conventional above-knee leg is the elimination of the pelvic hinge and all suspension harness. The muscles of the stump control all movements of the leg. The leg is held on by a slight negative pressure, or suction, created in the closed socket due to the weight of the leg as it is lifted from the ground. The socket is made to fit snugly in order to maintain an air seal, but should not restrict the muscles of the stump. No sock is worn on the stump. When the socket is properly fitted and has no leaks, there is no slipping of the skin relative to the side wall of the socket; the femur moves slightly within the soft tissues of the stump.

For most of the subjects fitted to date, the weight is supported mainly on the ischial tuberosity. A definite shelf is provided on the upper margin of the prosthesis, and the ischial tuberosity bears on this shelf. As compared with the conventional socket which distributes the load around most of the perimeter, the socket with an ischial seat causes less constriction of the tissues about the thigh and less variation in height with change in size of the stump. Although the concentration of weight of the body on the ischial tuberosity (which is posterior to the hip joint) tends toward the development of a lumbar lordosis, this tendency may be minimized by active use of the abdominal musculature.

A few subjects have used a "plug fit" in essentially a conventionally shaped socket, with apparent success. The plug fit minimizes the tendency toward lumbar lordosis, but in use the stump tends to slip farther into the socket as the size of the stump decreases and as the stump tissues contract. Experience with the plug fit has been limited; and this report deals with the suction socket having an ischial seat.

To put the suction socket on the stump, a thin sock is employed as shown by the series of photographs in Figure 1. The valve is removed, and the sock is pulled off and out through the valve opening. After the stump has been seated and is comfortable, the weight is put on the leg and the valve is screwed in to seal the socket.

Elimination of the conventional pelvic band and hinge gives the amputee more freedom and less interference with clothing. With the piston

action largely eliminated, the prosthesis feels more like an integral part of the body without so much dead weight, and it is capable of being more actively controlled.

No detrimental effects due to wearing a suction socket have been found. As with other artificial legs, sores have been caused by improper fitting or by improper alignment with the rest of the leg. The slight negative pressure required to hold the leg on has caused no measurable change in blood circulation. Although in some cases this negative pressure has caused some edema on the end of the stump, the edema either disappears spontaneously or is stopped by corrective measures described later herein.

INDICATIONS AND CONTRAINDICATIONS

As a rule, the suction socket cannot be expected to function where the conventional socket has been unsuccessful. Spur growths on the bone, sensitive nerve endings, or bad scars may be a handicap with either type of socket. A well-muscled cylindrical stump of medium length or longer is well suited to the use of a suction socket. Short stumps and bad scars cause difficulty in making a seal that will hold suction, but with care these cases have been successfully fitted. Scars which adhere to underlying bone are subject to stretching as the femur moves within the soft tissues while the skin is fixed to the wall of the socket; if this condition is severe enough it may lead to trouble. It is advisable in all cases that the construction and fitting be done in consultation with an orthopedic surgeon, especially one with experience in this special field.

Ordinarily, the suction socket can be profitably used for any thigh amputation for which the conventional type of socket may be used, subject to consideration of the following points:

The psychological attitude of the amputee is very important since the fitting and proper use of the suction socket requires more effort and cooperation on the part of the patient than does the conventional type of socket, particularly during the first weeks of use.

Associate injuries of the opposite leg, because of the lack of stability engendered by such injuries, tend to contraindicate the suction. However, bilaterals have been successfully fitted with suction

sockets.

Chronic skin infections such as allergies, boils, psoriasis, etc., are generally contraindications.

Except in definitely arrested cases, osteomyelitis is a contraindication.

Scars are not felt to be contraindications, since experience has shown that distal scars will free themselves and loosen up when under mild suction. Scars near the superior brim may cause leakage in the socket and make the fitting of a suction socket difficult. Scars adherent to underlying bone near the distal end of the femur should be fitted with caution.

High capillary fragility at the distal end of the stump is generally a contraindication. This may be characteristic of a person who bruises easily.

Vascular diseases are not felt to be contraindications, although present experience with these in conjunction with the suction socket is too limited to allow a generalization.

The suction socket when used in conjunction with a pelvic band has been found to be extremely helpful in fitting unusually short stumps.

CONSTRUCTION OF THE SOCKET

Material

The primary requirements of a material to be used in making a suction socket are simplicity in forming to the proper shape, adaptability to a surface finish to which the skin is tolerant, ability to maintain the inside clean and sanitary, and the possibility of making alterations as required by changes in the stump. Wood and plastic laminate have so far received the most attention. Because changes in size of the stump generally take place during the first months of wearing a suction socket, it is recommended that wood be used since it is simple to shape and allows alterations to be made as required. After the stump size has become established, in possibly six months to a year, a socket made of plastic laminate seems preferable because it is flexible in comparison with wood, will better withstand the use of soap and hot water, and is less affected by perspiration.

Shape

The wood socket is carved and shaped to fit each individual person, but it has been found that a definite pattern can be used for the rough out-

line of all sockets at the level of the ischial tuberosity. The measurement of the perimeter taken through the crotch and in the gluteal crease as shown in Figure 2 determines the pattern size. Use the pattern taken from Figure 3 that has the same perimeter or up to one-half inch less than the measurement. The pattern outlines are shown full-size in the figure and may be traced and increased or decreased for desired size. The perimeter length indicated on each pattern is the length measured around the outside of the ischial seat; the wood which forms the ischial seat lies inside of this perimeter. The cross-section shape of the lower portion of the socket is made in the usual manner, with proper regard for close fit.

A study of Figure 4 will indicate the principal muscle groups and other anatomical features that were considered in arriving at the average pattern shape. The male cross-section as shown in Figure 9 may be used as a reference. Obviously, the pattern is only a general outline; individual variation may be required depending on the musculature of the stump. Figure 5 shows an example of the deviations between the actual socket outline for one amputee and the pattern used for the rough fit. In general the greatest deviations occur for small cylindrical stumps and for large flabby stumps without much muscular development.

It should be pointed out that the anterior side of the socket at the pattern or ischial-seat level is usually undercut with respect to the superior brim above this region. The outline of the anterior side of the patterns shown in Figure 3 is such that sufficient wood is generally maintained for finishing the superior brim and such that it permits the removal of additional wood beyond the pattern outline for an undercut on the anterior side at the ischial-seat level. No other allowance for undercuts, which may be desirable in some cases, have been made in the typical pattern shape.

Medial Side.--The crotch line making the channel for the adductor muscles is kept narrow, and the height with respect to the ischial seat is varied in almost every socket. Since there is relatively little piston action in a suction socket, some weight can be borne through the medial side with no ill effect, thus relieving some of the pressure on the ischial

tuberosity. The height of the medial side is governed by comfort of the amputee in the socket. From the ramus to the anterior-medial apex (adductor longus), the medial side can rise, remain level, or fall as governed by comfort, yet the variation should not exceed one-quarter inch above nor more than one-half inch below the ischial-seat level. If a medial or adductor roll is present, the socket is enlarged on that side to accommodate the excess tissue which is pulled into the socket and eventually diminishes.

Anterior.--The front of the socket is kept very snug, but not so tight as to produce pressure over the femoral triangle and thus impair circulation in the stump. In order to hold suction in this region, a slight undercut is made approximately one-half inch below the top of the superior brim with a long taper to the undercut.

Lateral Side.--The lateral or outer side is kept high, but not over the trochanter. The highest point on the superior brim is forward of the trochanter with a slope across the front to the medial or crotch side, but in no case should it be so high as to interfere with hip flexion or abduction.

The lateral side of the socket is undercut in some cases, depending on the muscular development in this region. This undercut may be desirable for flabby or skinny stumps, but is not required in the majority of cases where the side is made fairly straight. An examination of the individual should easily determine this shape. If an undercut is used, it can start about one inch below the top and continue for several inches. Below the maximum undercut the outside should taper in somewhat, to provide support for the femur above the distal end as abduction takes place when weight is placed on the leg.

The desire for an undercut on the lateral side has been questioned on the ground that it does not allow equalized pressure on the femur from the top to near its distal end. Since the femur has been established as the body stabilizer during the stance phase, an undercut would distribute the pressure unevenly and thus allow most of the pressure to be taken at the top of the socket and below the undercut; it should be used only on stumps that have trouble holding suction.

The protuberance which is left in the socket adjacent to the back of the greater trochanter is very important because of the stability it gives during walking. It assists in maintaining the position of the ischium on the ischial seat, it helps to resist the tendency for the leg to rotate, and it aids in holding suction, especially during sitting. This protuberance can be prominent and still not disturb any muscular activity, as indicated by the anatomical cross-section shown in Figure 4. If contact between the trochanter and the protuberance causes discomfort, it can be relieved by lowering the superior brim in this region.

Posterior.--The back of the socket is very important in an ischial-bearing socket. Relief for the gluteus maximus muscle depends on the individual, but in most cases where there has not been much atrophy or distortion, this region of the socket can be lowered below the ischial-seat level with a gradual tapered roll outward.

Relief for the adductor muscles or the crotch line can often be made by relieving the gluteus maximus. Too tight a fit on the gluteus maximus can cause crowding of the adductor muscles in the crotch section. The ischial tuberosity can be moved back on the ischial seat of the socket by lowering and relieving the gluteus muscle channel. However, lowering this section increases pressure on the ischial tuberosity. Should additional room be needed within the socket, the lateral side of the gluteal channel can be made wider just posterior to the protuberance. The gluteal channel should be widened instead of cut deeper posteriorly, as a deeper channel will protrude posteriorly at the point of contact on the socket while sitting and will form a hump or radius on which the leg will rotate while sitting, thus causing a burning sensation of the skin under the ischial tuberosity. The effect will be even more prominent if there is an undercut below the ischial seat.

Ischial Seat.--The importance of the ischial seat on the socket cannot be overemphasized. It should be accurately located under the ischial tuberosity, and individual variations must be taken into account. If the wood is left as large as indicated on the pattern, there will be ample remaining for proper shaping. The seat should be adequate, but should not be

so wide as to cause discomfort while sitting. Slipping of the ischial tuberosity to either the inside or the outside of the seat creates a great deal of discomfort. This may be prevented and the socket rendered more comfortable by shaping the bearing surface into a slight concavity, or by slightly sloping the seat toward the front. This sloping increases the radius of the ischial-seat edge, and this change also lessens the burning sensation of the skin.

If the ischial seat is too prominent, a jabbing sensation or a marked increase in pressure occurs near the end of the step. Lowering the ischial seat allows some weight to be distributed to other parts of the socket, and -- if the ischial tuberosity is properly located on the seat -- it results in less discomfort and a shorter required breaking-in period.

Tightness of Fit

Initially, too much emphasis was given to tightness of fit. Better results have been obtained by having proper contours rather than a tight fit. If much difficulty is encountered in removing the thin sock during insertion of the stump into the socket, it is an indication that the fit is too tight. The superior brim of the socket should be fit snugly, the middle portion of the stump should fit the walls closely, and the distal end of the stump should be free but not loose within the socket. Too tight a fit around the top may cause pressure on the femoral veins with resulting edema.

Free Space at End of Stump

The amount of unoccupied volume at the lower end of the socket is not critical with regard to obtaining sufficient suction. In most cases it is convenient to have approximately two inches below the end of the stump to provide space for installation of the valve and room for elongation of the stump. In general, the smaller the volume in the end of the socket the less the excursion; but the amount of free volume in itself has no effect on the magnitude of the negative pressure.

End bearing is recommended if it can be tolerated, since it relieves the load on the ischium and reduces tendency toward lordosis. Felt padding placed in the bottom of the socket will permit comfortable end

bearing; the thickness of felt padding governs the amount of weight carried on the end of the stump. Although little free space remains in the socket, adequate suction and control are not affected. Gritti-Stokes amputations which were mostly end bearing have been very easily and successfully fitted.

Inside Finish

No definite recommendation can be made at this time regarding adequate finishes to which the skin is tolerant. Industrial lacquer and flesh enamel paint, thoroughly dried, have each been used, but some subjects have reported slipping in the socket due to perspiration. In some cases perspiration has also caused the laquer finish to deteriorate, producing particles which cause skin irritation. Paraffine wax has been unsuccessful in most cases tried. A satisfactory finish has been obtained using a paste wood-wax with a beeswax base which was installed initially by heating the wood, applying a number of coats, and polishing each coat well into the wood. Cellulose acetate dissolved in acetone has been the most generally successful inside finish.

Bottom Seal

The bottom of the socket should be sealed with a piece of hardwood 1/4 to 1/2 inch thick, cut with the surface along the grain and sealed with a waterproof glue. Soft wood, with large pores in the grain, and plywood are not satisfactory for this purpose.

Valves and Installation

Several different types of valves have been used with good results. A simple plug type with manual release of suction has been satisfactory. Automatic expulsion valves permit some change of air in the socket, which change is beneficial during hot weather and times of perspiration. Automatic expulsion valves have proven successful in all cases tried, and they are now generally used. Two types are shown in Figure 7.

The valve opening should be located for ease in removing the thin sock when the leg is being put on, for convenience in operating the valve manual control, and where there is no possibility that the distal end of the stump will contact the inner face of the valve. Most valves have been lo-

cated toward the front on the medial side and below the stump.

Care should be taken that the valve insert is securely glued in the socket wall and is completely air tight.

The magnitude of negative pressure, or suction, required to hold the socket in place is only slightly greater than the weight of the prosthesis divided by the cross-sectional area of the stump near the distal end. In most cases the weight divided by the area is about 1½ pounds per square inch; with the additional support given by contracting the stump muscles during each step, a negative pressure of 1½ pounds per square inch should be sufficient. Most amputees prefer somewhat greater suction with its accompanying feeling of security; however, excessive suction may cause edema. A negative pressure greater than about 1½ pounds per square inch is an indication that forces are present tending to pull or push the leg off the stump. This action may take place when the stump muscles are contracted; or it may be a result of improper fit around the superior brim of the socket, which produced constriction of muscles. The use of a gage for measuring the maximum negative pressure at the time of the rough and the final fittings in an excellent check on the quality of fit and is essential to good and consistent results.

Many accurate records have been made of the variation of pressure in the suction socket during normal walking. With the automatic expulsion valve now in general use, these records show a small positive pressure during weight-bearing and a negative pressure while the leg is in the swing phase of the step. Figure 8 is a record of the pressure variations in a suction socket during two complete walking steps. During weight-bearing the pressure is greater than atmospheric. The valve used during this test permitted automatic exhaust starting at a positive pressure of ½ pound per square inch.

The stiffness of the spring in the valve has no direct effect, in itself, on the magnitude of the maximum negative pressure. It may allow a greater or lesser amount of air to be expelled at each step and would thereby affect the amount of piston action and the type of fit around the top of the socket; the change in fit might result in the development of forces tending to push the leg off and thereby producing higher negative pressures. A

spring permitting expulsion at a positive pressure of one-half pound per square inch is satisfactory in most cases.

Some leakage generally occurs either in the valve, through the socket, or between the socket wall and the stump. This leakage in proper amount is desirable as it relieves the suction during periods of inactivity. If the suction drops to one-half its initial value while hanging from the relaxed stump in from 50 to 80 seconds, the leak rate has been found to be satisfactory. If this time is much greater than 100 seconds, the manual release should be used during periods of inactivity, or edema may result. If the leak rate is too great, more piston action may occur with resulting discomfort, or the leg may fall off.

Alignment

With the conventional leg, poor alignment has sometimes been made less apparent, although not corrected, by the location and adjustment of the pelvic joint. With the suction-socket leg, which has no pelvic joint and which is controlled entirely by the stump muscles, alignment becomes even more important and must be correct for proper control and comfort. If the alignment is not correct there is a definite whip of the prosthesis during walking.

The problem of alignment has not been completely solved, and opinions differ as to what constitutes the ideal alignment of the prosthesis. Theoretically, considerable knock-kneeing is advantageous in that it tends to suppress body sway and limp; however, too much knock-kneeing may produce a medial whip during the free swing. If the leg is bowed too much, a lateral whip may occur. The proper amount of knock-knee is critical. Various limb manufacturers have devised their own methods of achieving alignment.

Allowance should be made for flexion and abduction contractures which are prone to occur in short stumps. Modification in these cases may be necessary both in shaping the socket and in aligning the socket with the rest of the leg.

USE AND ADJUSTMENTS

For an amputee not accustomed to supporting the greater part of his body weight on the ischial tuberosity, the ischial-seat type of socket may cause an initial period of discomfort. As the ischium becomes accustomed to weight bearing, all reports indicate that this is a comfortable type of prosthesis. Elimination of the pelvic belt and hinge allows greater freedom of motion and a reduction in the dead-weight feeling of the prosthesis, but in the beginning it may create a feeling of instability which requires active use of the stump muscles before proper control of the leg has been achieved. The early periods of wearing a suction socket may thus be accompanied by both physical and mental fatigue, and in some cases it may be necessary to increase the use of the suction socket gradually. During the first few months it is sometimes advisable to use a simple type of web safety belt with two crossed webbing straps for additional security and resistance to rotation.

In general, some shrinkage of the stump will take place during the first several weeks of usage. If sufficient shrinkage occurs to cause loss of suction, a liner should be installed; but this liner should be removed when it is no longer required. The period of initial shrinkage is generally followed by muscular development and growth.

Development may occur in the major muscle groups, notably the adductors, extensors, and glutei, which may require adjustments of the socket for proper relief. Relief for one muscle may affect other regions; therefore care should be used in modifying the socket shape. When the stump develops to the point where weight is not being carried on the ischial seat, it may be necessary to relieve all the muscle channels.

Rotation of the leg and consequent sores on the stump, particularly in the region of the ischial seat, may be controlled to a large extent by proper alignment and socket shape.

Edema at the end of the stump should be prevented. With a proper fit and with suction that is not excessive, edema either does not occur or soon disappears. If too high a negative pressure is used, edema may be accompanied by minute skin hemorrages. Negative pressures should be held to

the minimum that will keep the leg on, and seldom if ever should exceed a peak value of 2 pounds per square inch. The presence of edema in stumps with poor circulation and excessive scar tissue may lead to lowered local resistance and greater likelihood of infection. If edema persists, the following items should be investigated as possible causes:

Shape of the upper end of the socket with regard to pressure over the femoral triangle, leading to constriction of the vessels; or a shape which constricts the muscles during contraction and thereby tends to push the socket off and thus to produce an increased negative pressure.

Constriction just above the distal end of the stump, which impairs circulation.

If these items are found satisfactory but edema still persists, it may generally be controlled by light cushioning with a sponge-rubber pad in the bottom of the socket to produce a small amount of positive pressure on the affected area. If the edema extends up the medial side of the stump, it is indicated that the circumference at that level is too great and that during walking the stump, by abduction, leaves the medial side unsupported and hence exposed to the negative pressure.

Perspiration has been a minor problem to date. Where it is excessive, silica gel crystals may be placed in the bottom of the socket to absorb the moisture. Silica gel can be purchased from any drug store. The crystals should be placed in a small cloth sack, such as a "Bull Durham" sack, and placed in the bottom of the socket. If perspiration is excessive at least two sacks may be necessary, the one not in use being placed in a hot dry place to drive off moisture and make it ready for re-use.

EXAMPLE OF COMMON ERRORS

Figure 6 is a comparison of two wooden sockets made for the same stump. The one shown by the two views (A) at the left was satisfactory and wearable; the other shown by the two views (B) at the right was unsatisfactory. Socket A was finished with cellulose acetate and socket B with flesh enamel paint. Attention is directed to certain errors of shape and construction in the unsatisfactory socket that should be avoided, as follows:

The ischial seat is prolonged too far to the medial side, causing pressure on the ramus and constriction of the adductors.

The width and location of the ischial seat results in lateral displacement of the stump in the socket, with undue pressure on the lateral and distal end of the femur.

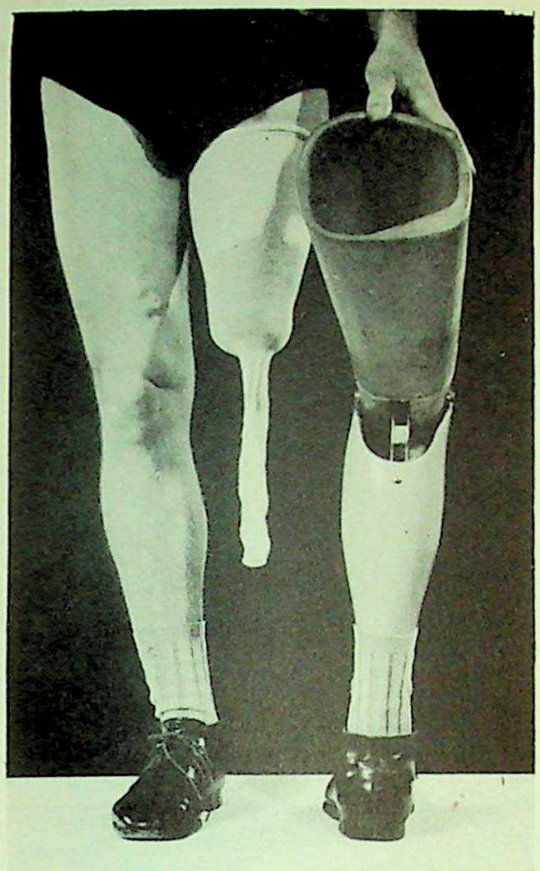
The ischial seat is too high with respect to the medial and gluteal channels, resulting in the entire weight being carried on the ischial seat.

The shelf-like form of the ischial seat due to the undercut causes stretching of the skin over the sharp border or edge and results in a burning sensation in the skin.

The gluteal channel is cut too low and is too narrow, causing loss of suction while sitting.

The inside has not been properly finished; the surface is very rough.

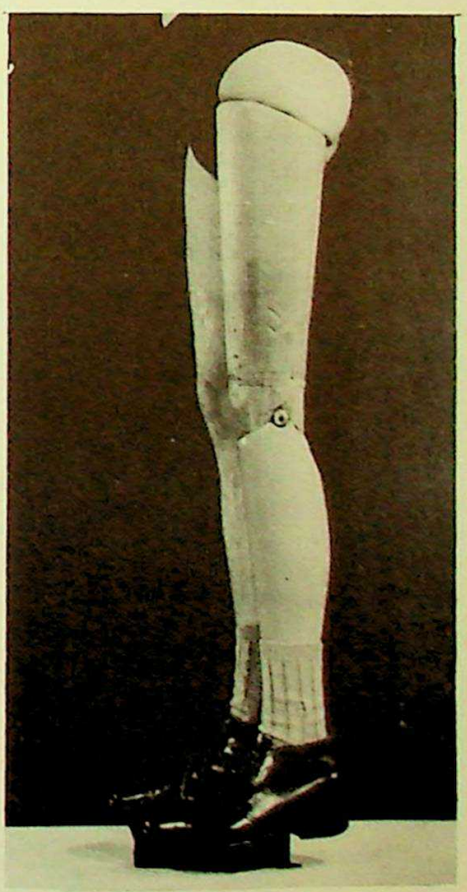
Both sockets have filled tack holes left from the rawhiding process. This error should be avoided by sewing the rawhide with a sack needle. The ischial seat should be smooth to produce the greatest comfort in this area.



A. STOCKINETTE ON STUMP

B. REMOVAL OF STOCKINETTE

C. INSERTION OF VALVE



D. LEG SUSPENDED BY NEGATIVE PRESSURE

FIG. 1- PROCEDURE FOR PUTTING ON SUCTION SOCKET LEG

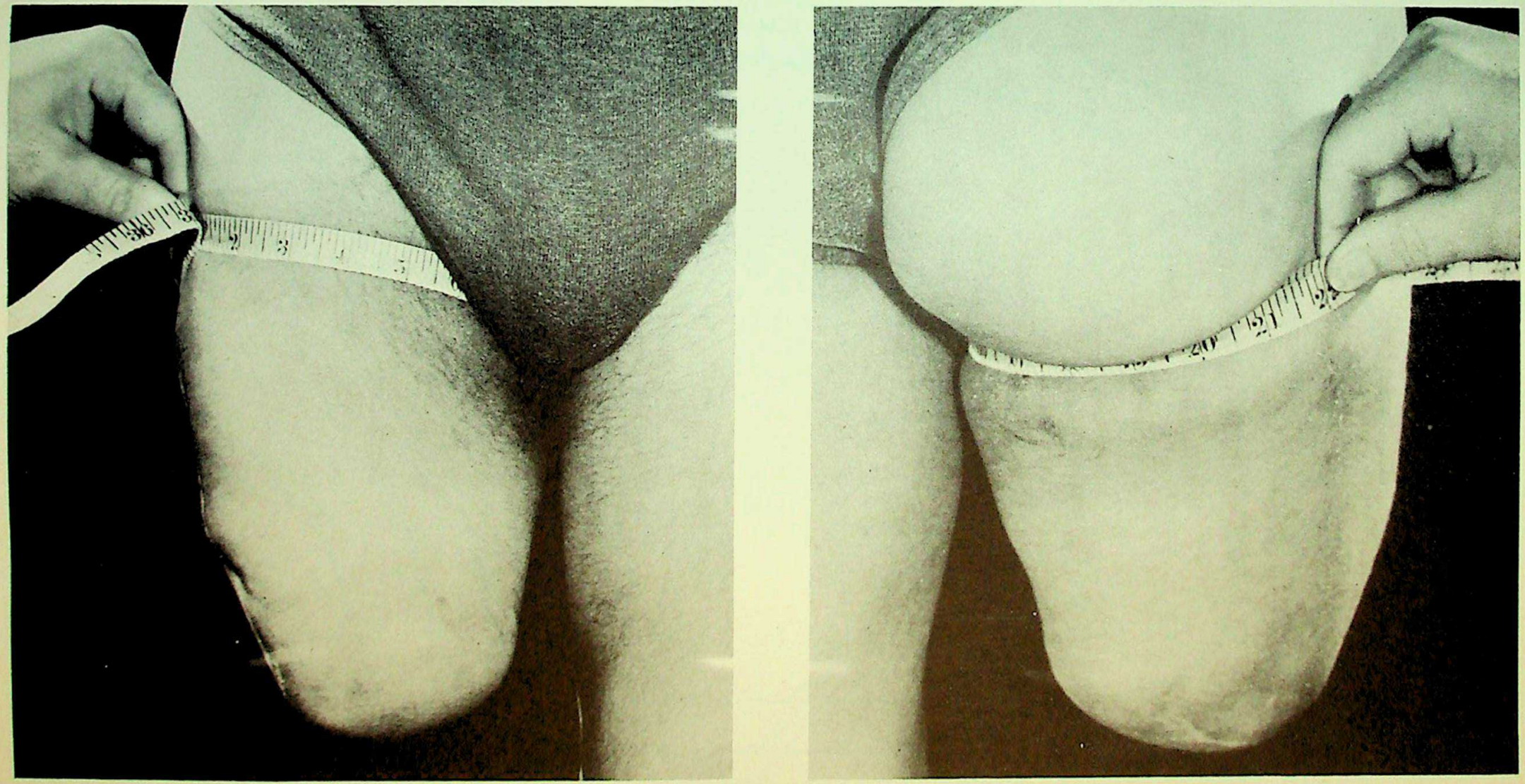


FIG. 2 - PERIMETER MEASUREMENT FOR DETERMINING PATTERN SIZE

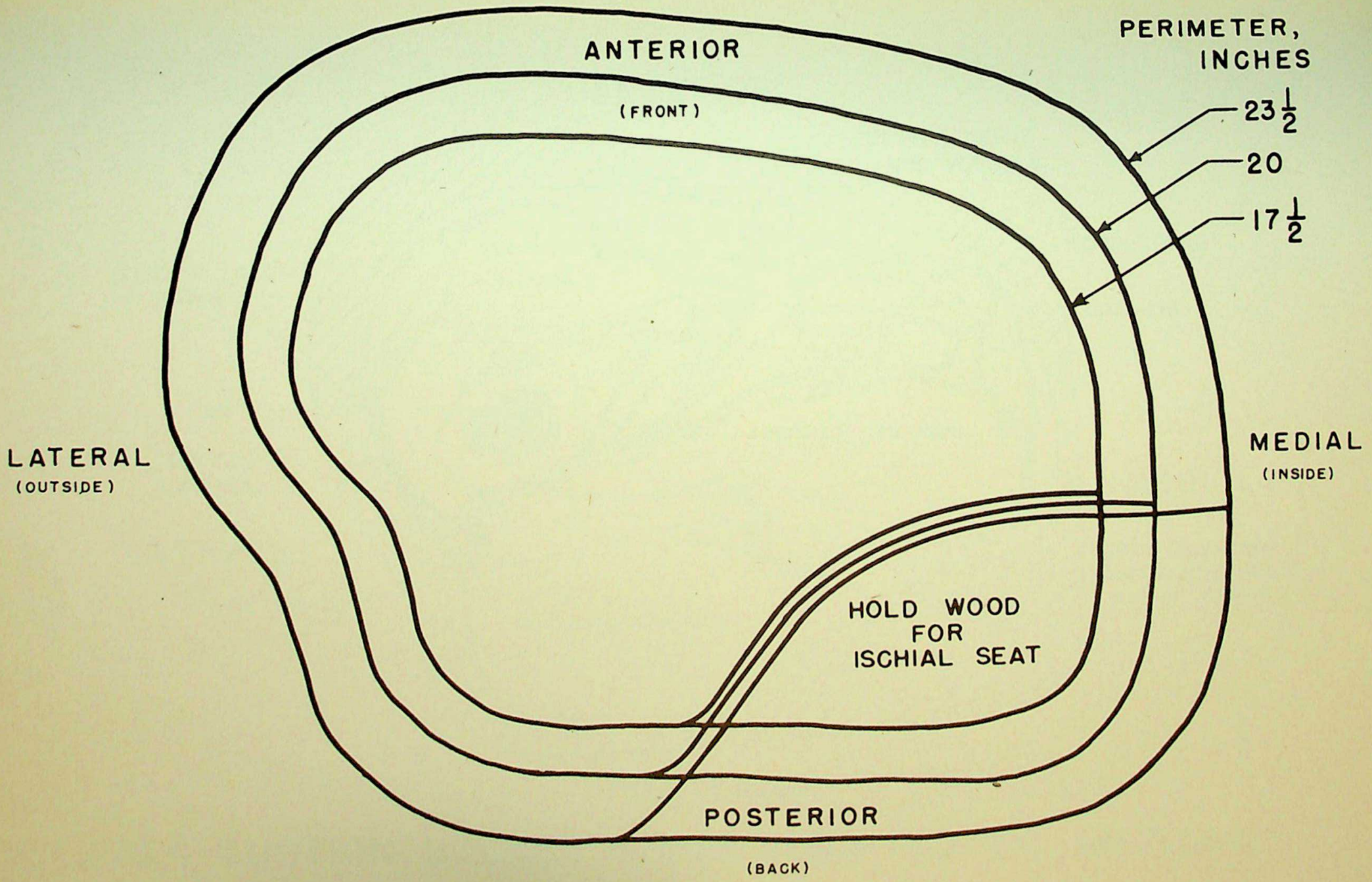


FIG. 3 - CROSS-SECTION PATTERNS AT ISCHIAL SEAT LEVEL

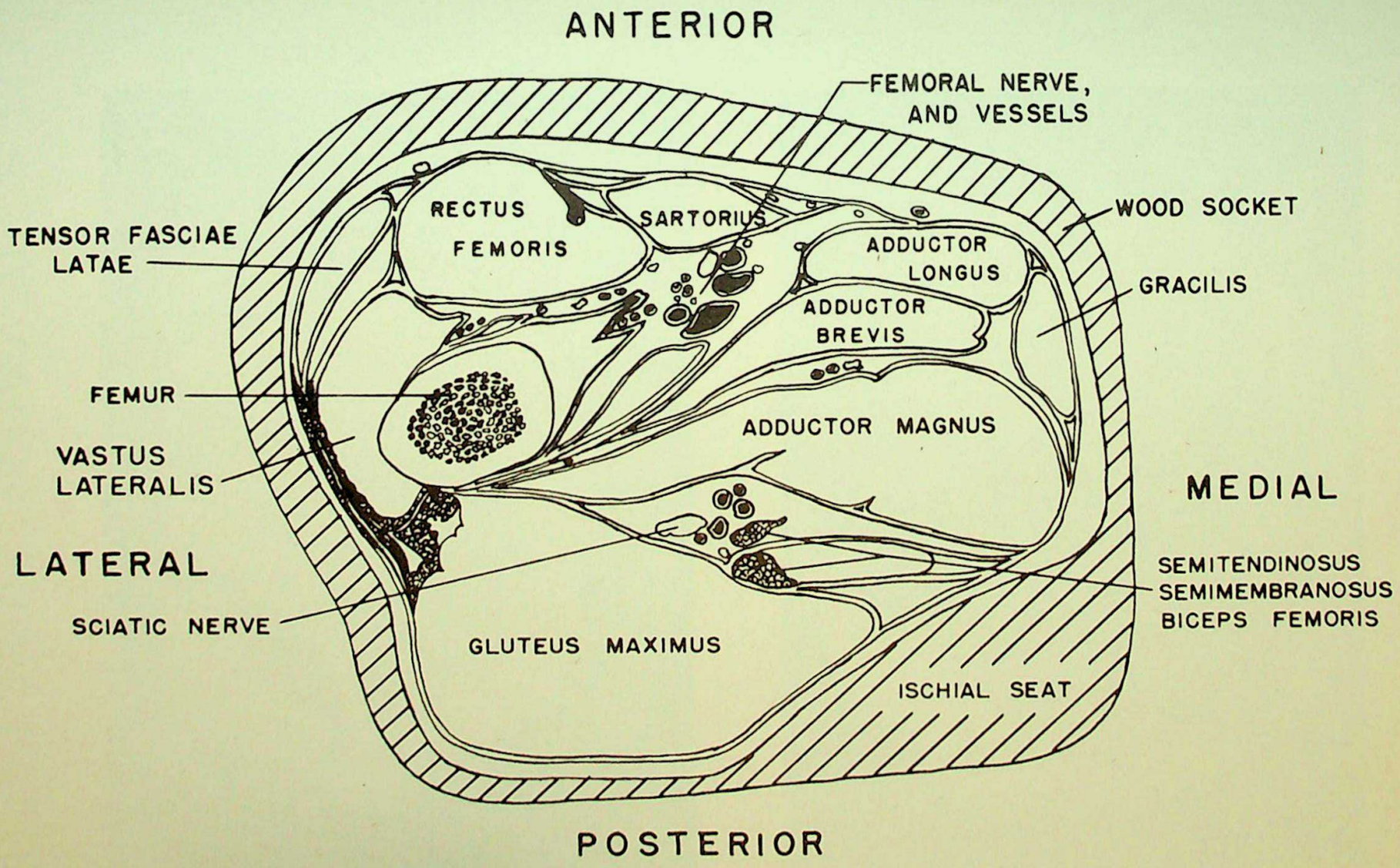


FIG.4-SUCTION SOCKET SHAPE ADAPTED TO ANATOMY OF CROSS-SECTION OF THIGH AT ISCHIAL SEAT LEVEL

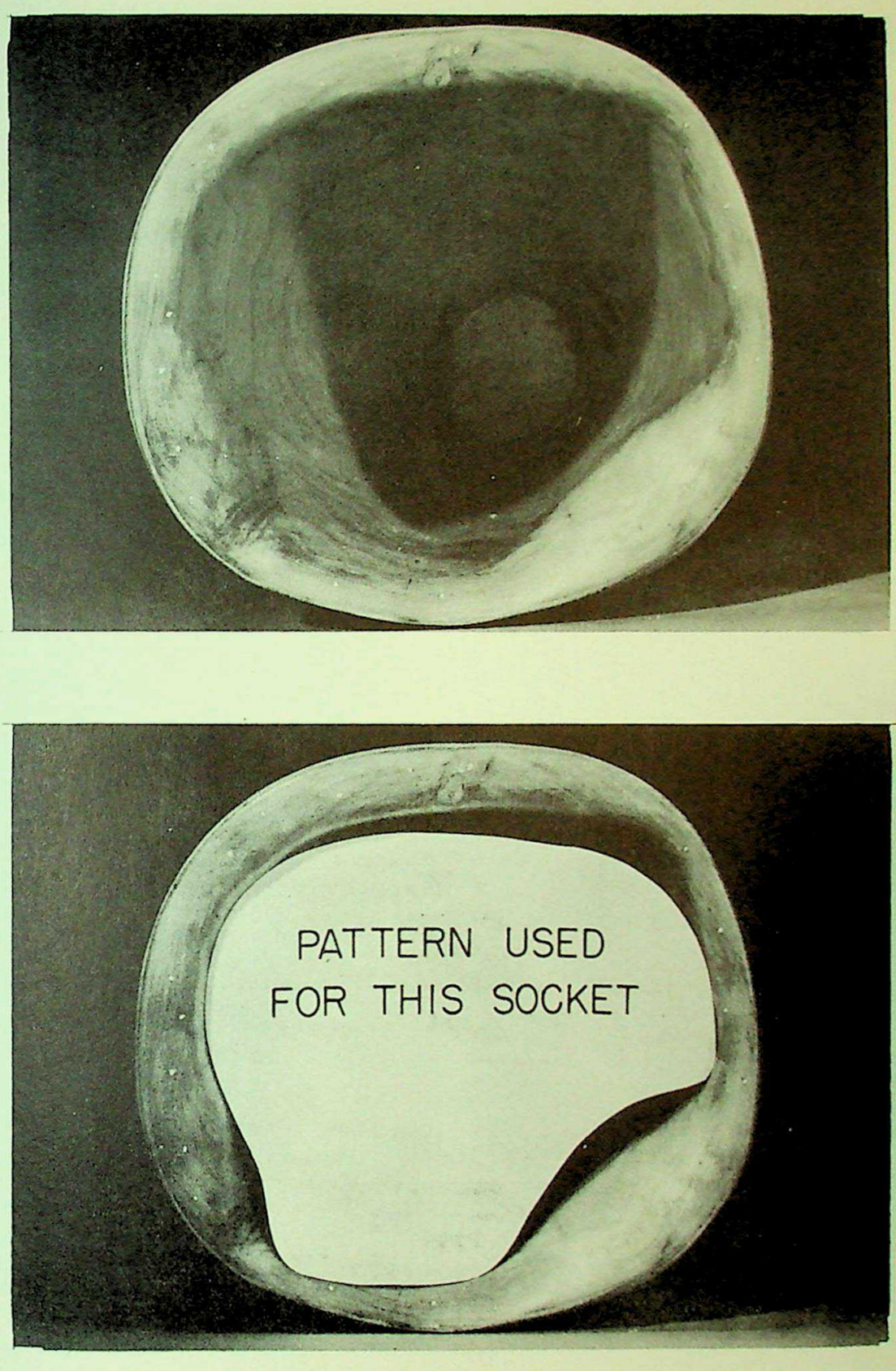
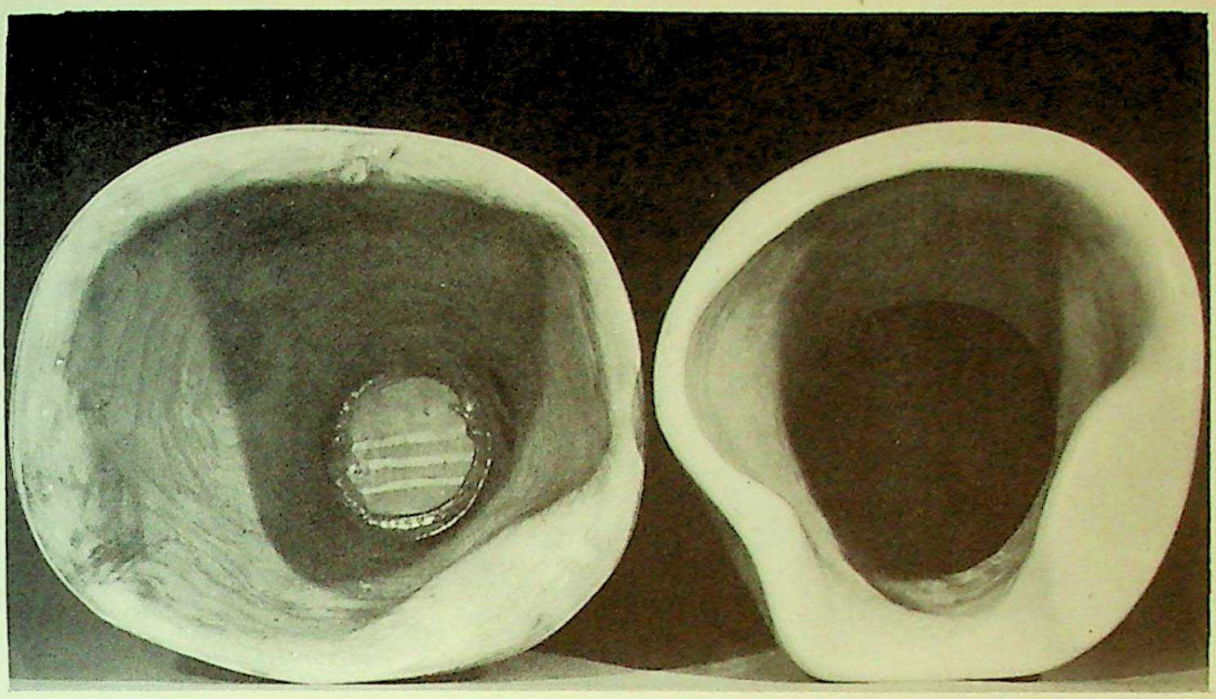
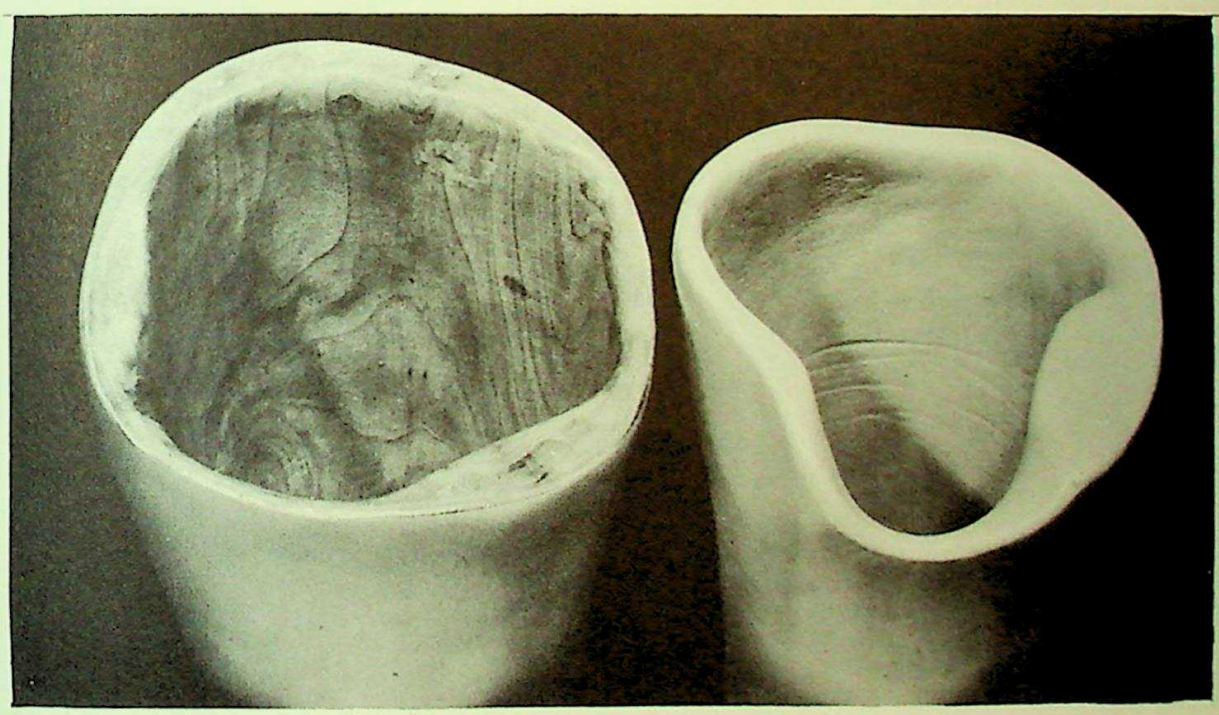


FIG. 5 - DEVIATION FROM PATTERN OF A TYPICAL SUCTION SOCKET



A B



A B

FIG. 6 - SATISFACTORY (A) AND UNSATISFACTORY (B) SUCTION SOCKET FOR THE SAME STUMP

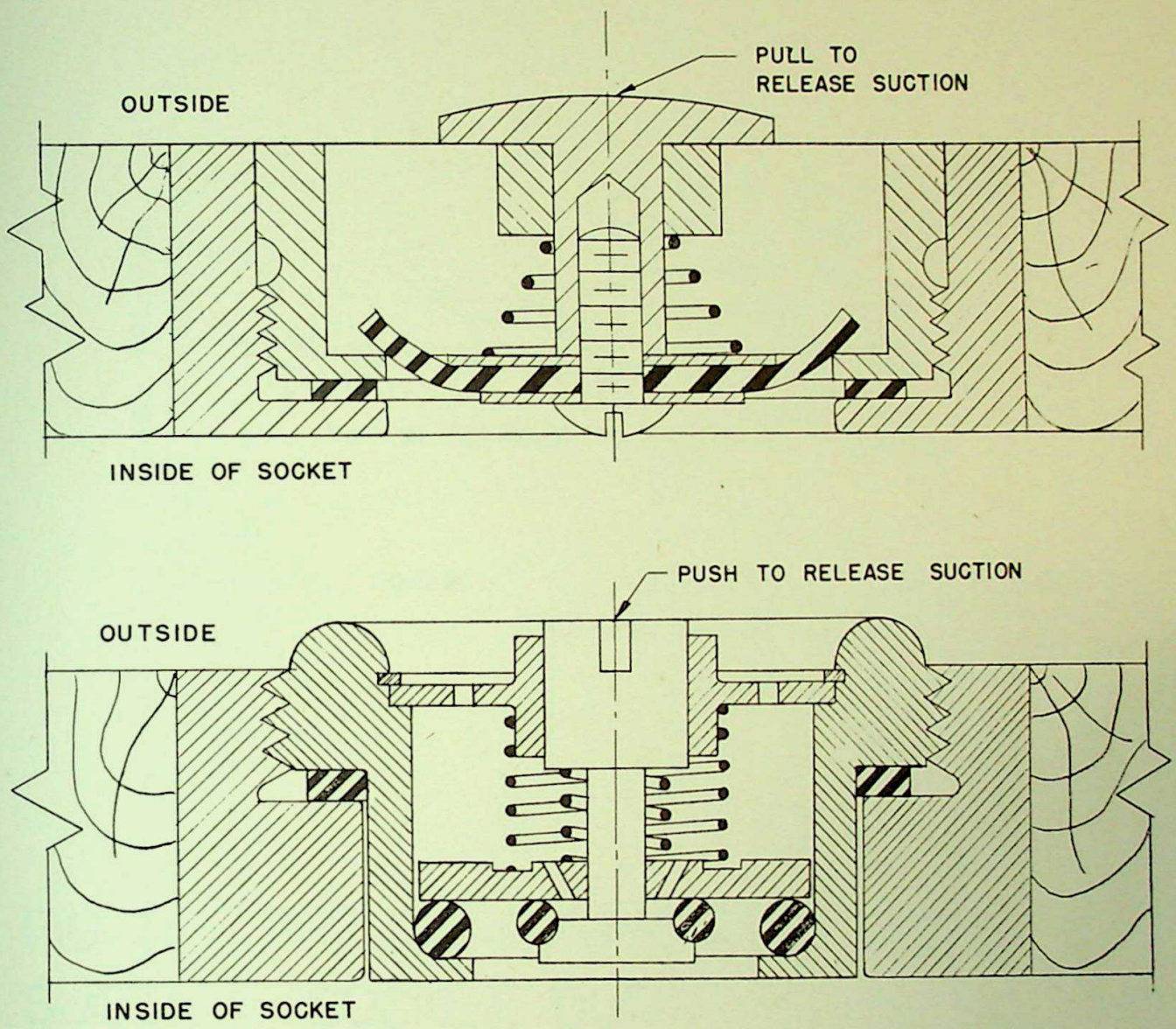


FIG. 7 - TYPICAL AUTOMATIC EXPULSION VALVES FOR SUCTION SOCKETS

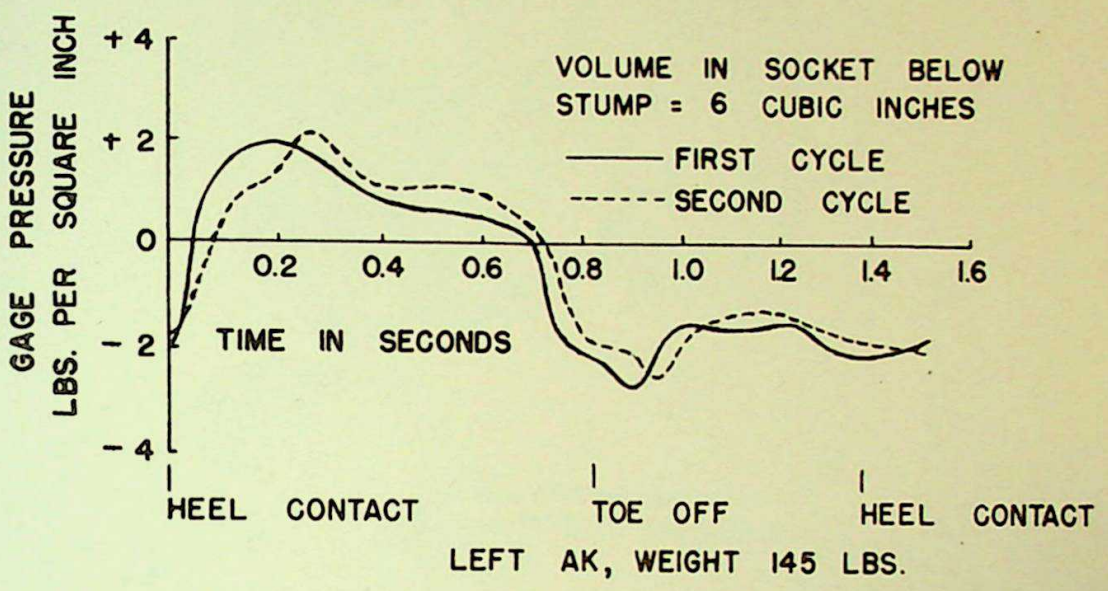


FIG. 8 – PRESSURE VARIATION INSIDE A SUCTION SOCKET DURING LEVEL WALKING

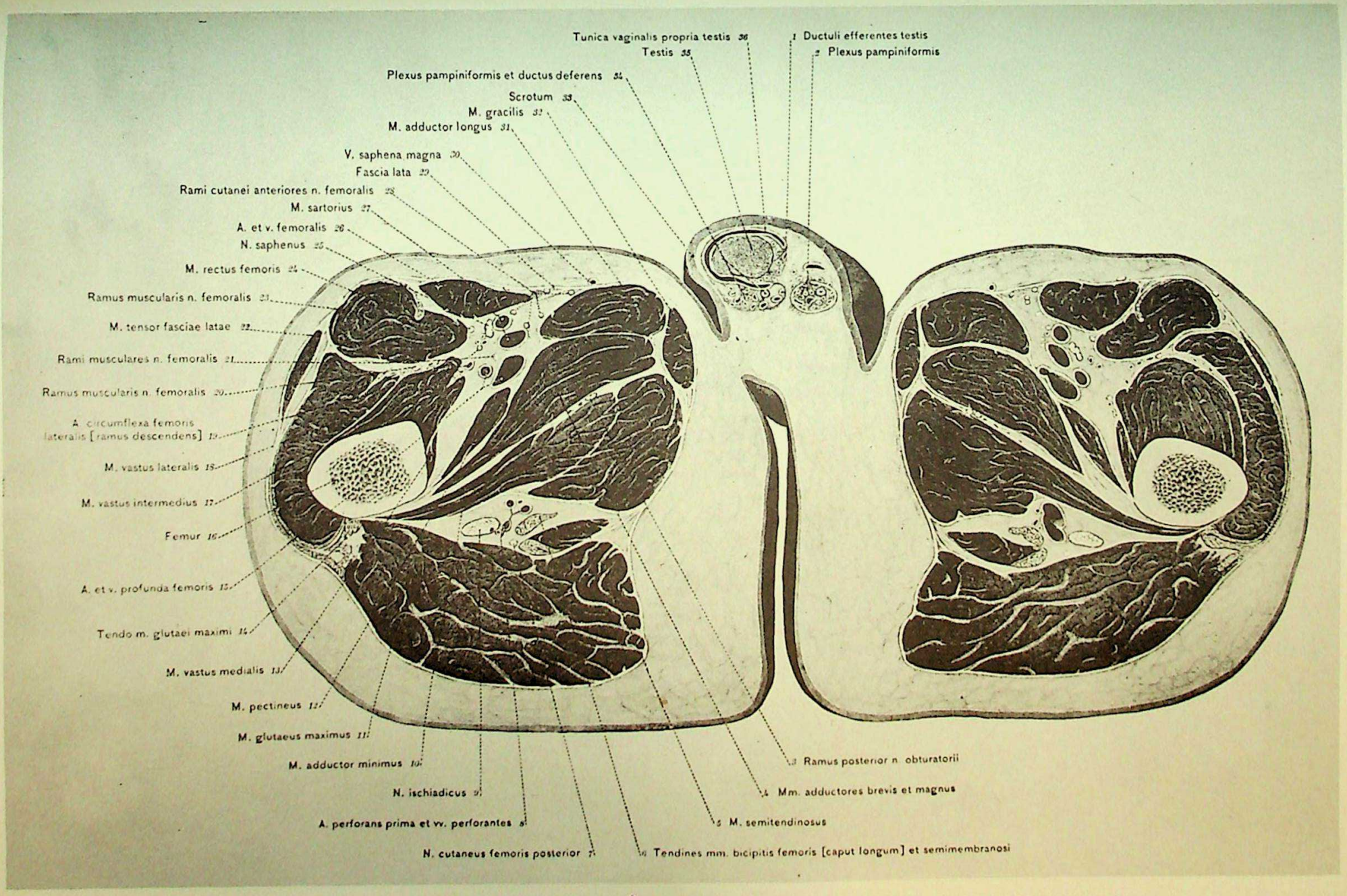

Tunica vaginalis propria testis 36
Testis 35
Plexus pampiniformis et ductus deferens 34
Scrotum 33
M. gracilis 32
M. adductor longus 31
V. saphena magna 30
Fascia lata 29
Rami cutanei anteriores n. femoralis 28
M. sartorius 27
A. et v. femoralis 26
N. saphenus 25
M. rectus femoris 24
Ramus muscularis n. femoralis 23
M. tensor fasciae latae 22
Rami musculares n. femoralis 21
Ramus muscularis n. femoralis 20
A. circumflexa femoris lateralis [ramus descendens] 19
M. vastus lateralis 18
M. vastus intermedius 17
Femur 16
A. et v. profunda femoris 15
Tendo m. glutaei maximi 14
M. vastus medialis 13
M. pectineus 12
M. glutaeus maximus 11
M. adductor minimus 10
N. ischiadicus 9
A. perforans prima et vv. perforantes 8
N. cutaneus femoris posterior 7
1 Ductuli efferentes testis
2 Plexus pampiniformis
3 Ramus posterior n. obturatorii
4 Mm. adductores brevis et magnus
5 M. semitendinosus
6 Tendines mm. bicipitis femoris [caput longum] et semimembranosi

FIG. 9-MALE CROSS-SECTION $\frac{1}{2}$ INCH BELOW ISCHIAL TUBEROSITY

REF: CROSS-SECTION ANATOMY BY EYCLESHYMER & SHOEMAKER, D. APPLETON & CO., 1911